

# Digital Effects Box for Guitar Design Overview

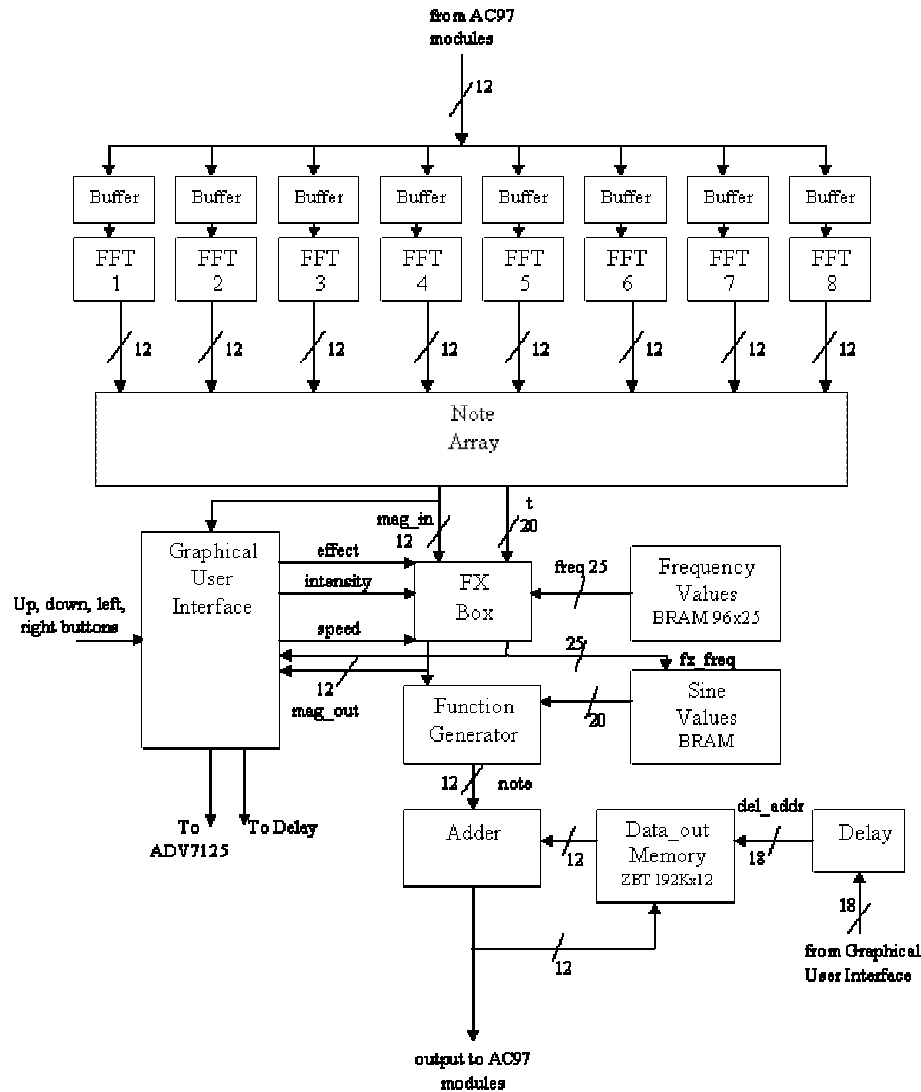
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6.111 Final Project

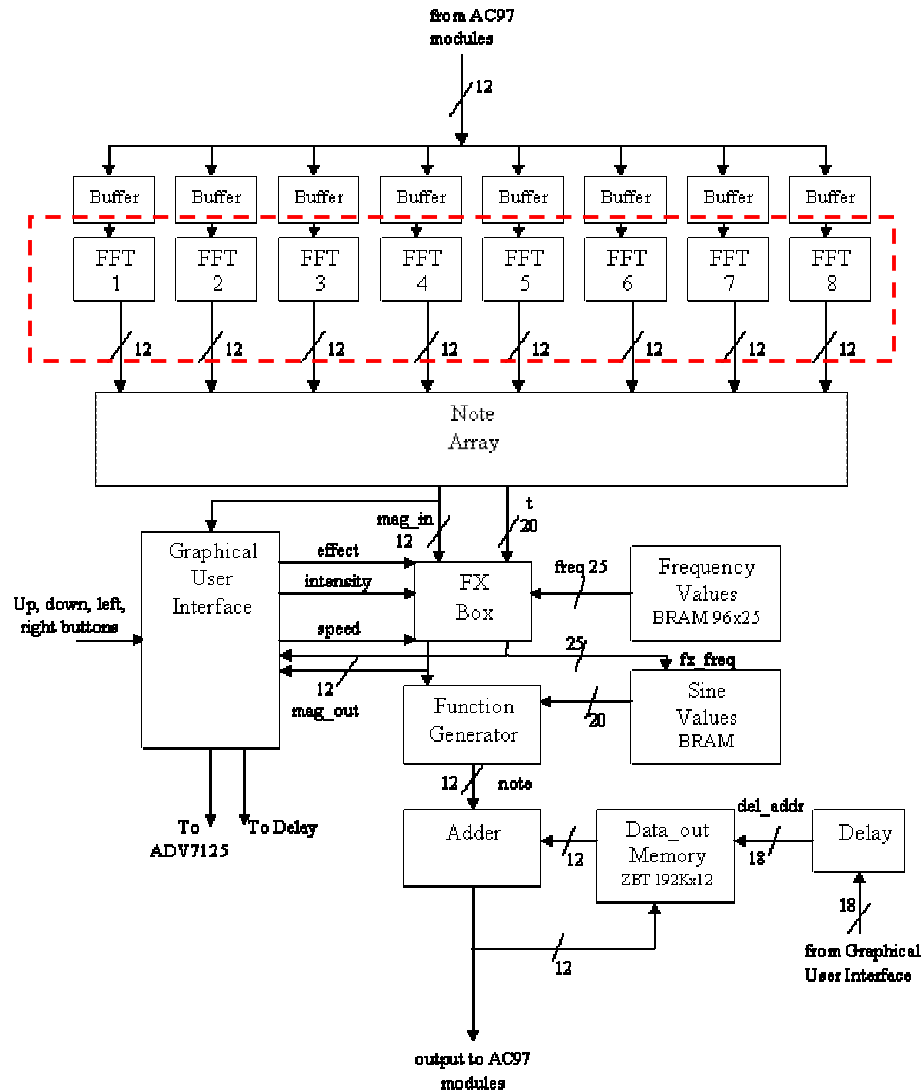
# Design Goals

- Real-time processing of audio signal
- Create effects in the frequency domain
- Visual interface for effect manipulation
- Visualization of effect on spectrum

# Block Diagram



# FFT

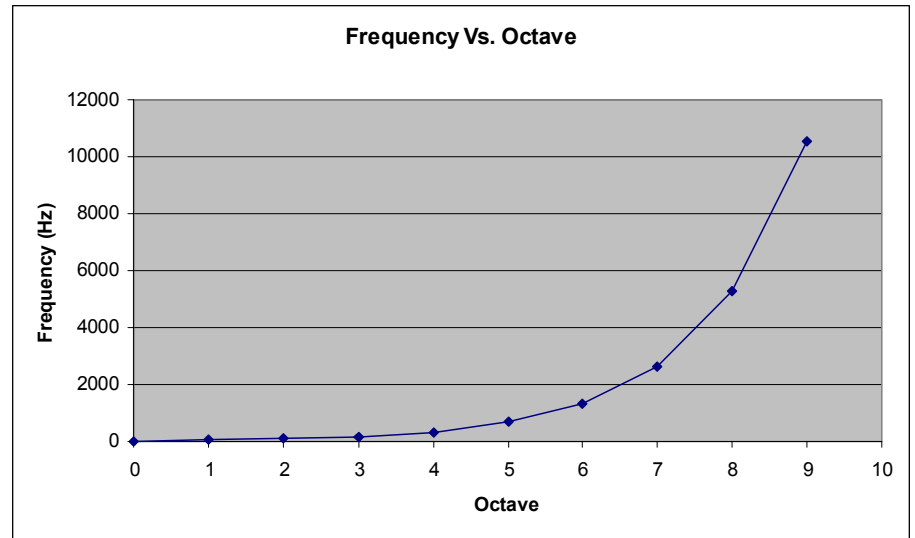


# FFT Module

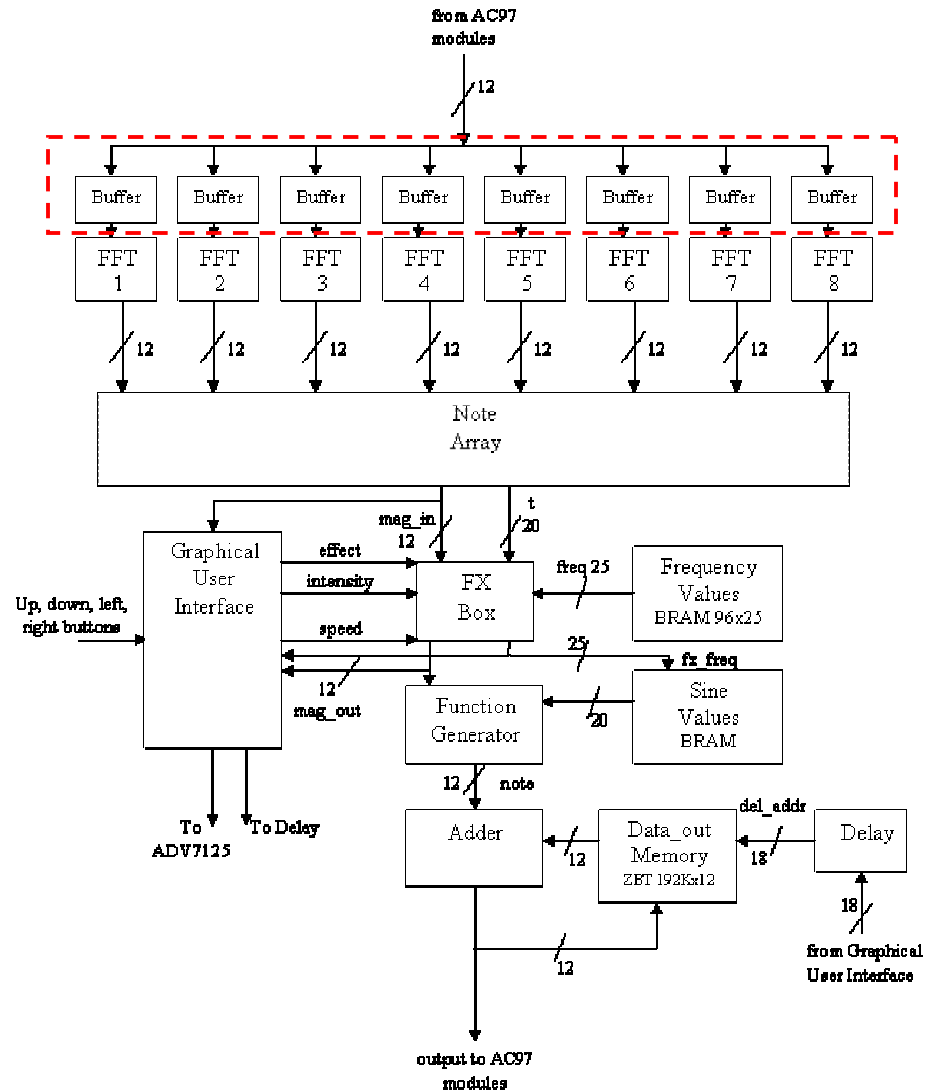
- FFT module is defined by two parameters: sample rate and number of samples
- Output is magnitude of frequency band, where:  
$$\text{bandwidth} = \text{Sample Rate} / (2 * \text{Number of Samples})$$
- Use 8 instances of Xilinx 128-pt FFT
- Each instance takes in 128 samples from AC97 module at a different sampling rate, from 384 Hz - 48 kHz
- Each FFT corresponds to one octave of tones

# FFT Module con't

- Musical pitch is logarithmic in frequency
- Resolution of frequency bands needs to be much higher at lower frequencies, on the order of 3 Hz
- At higher frequencies, resolution only needs to be on the order of 500Hz



# Buffer

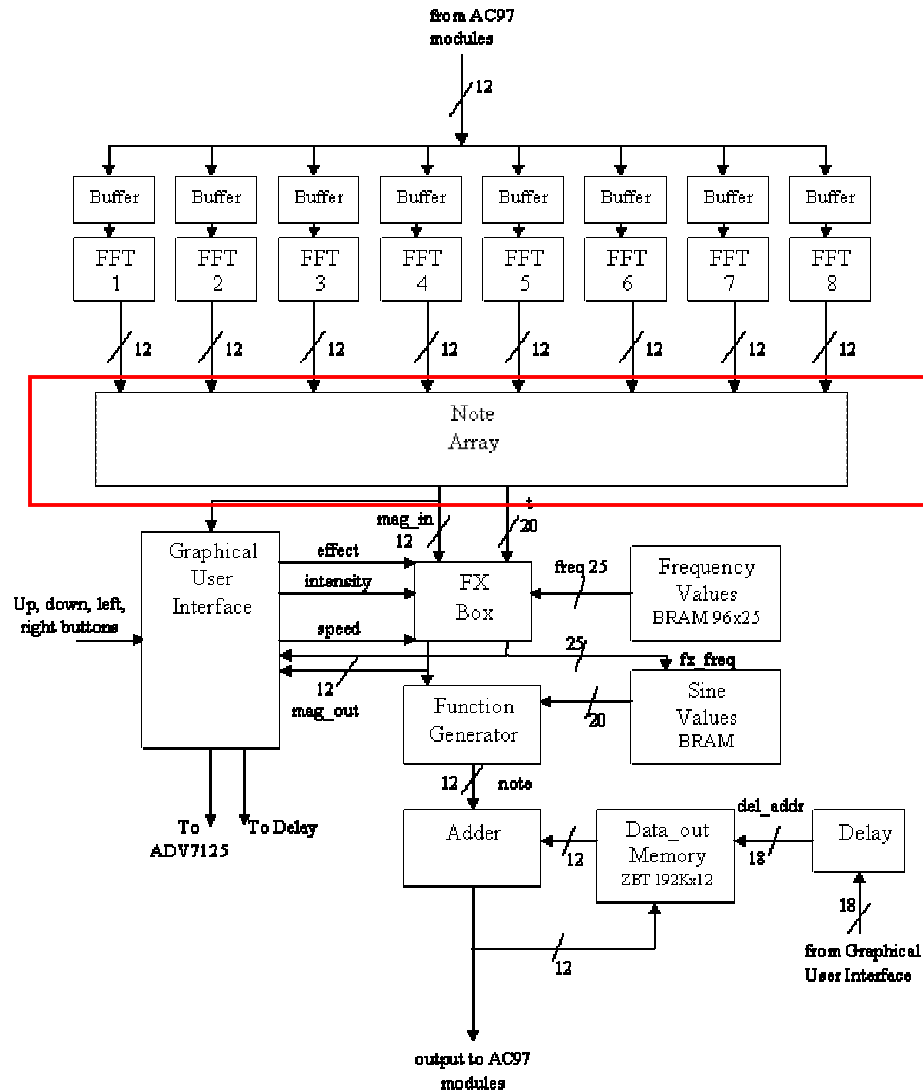


# Buffers

- Data is fed into buffers from AC97 module
- Buffers control sampling rate of data
- Send control signal to FFT



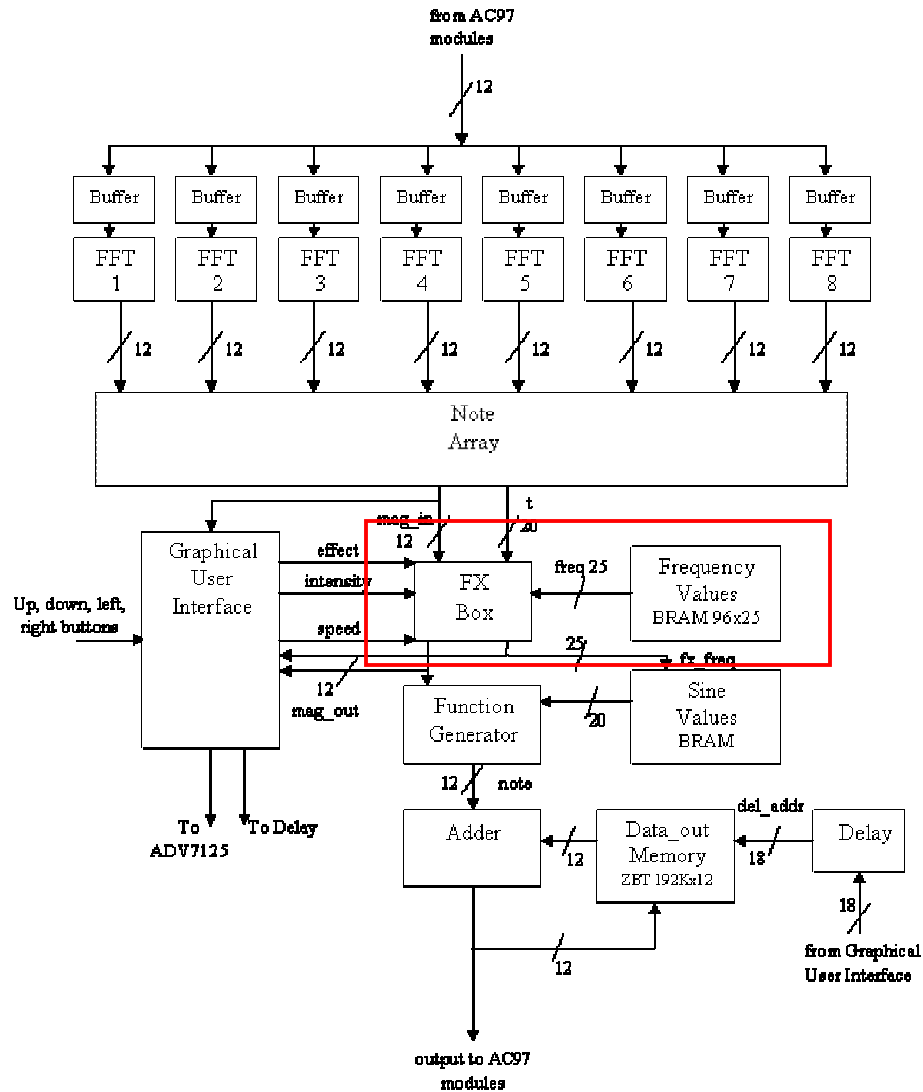
# Note Array



# Note Array

- 96 value array, corresponding to all notes over 8 octaves
- Will receive magnitude information for each possible note, in order from highest to lowest, from each FFT
- Serves as a “pitch-corrector”
- Records how long a certain pitch has been active
- Outputs magnitudes and timing information for a specified order of frequencies

# FX



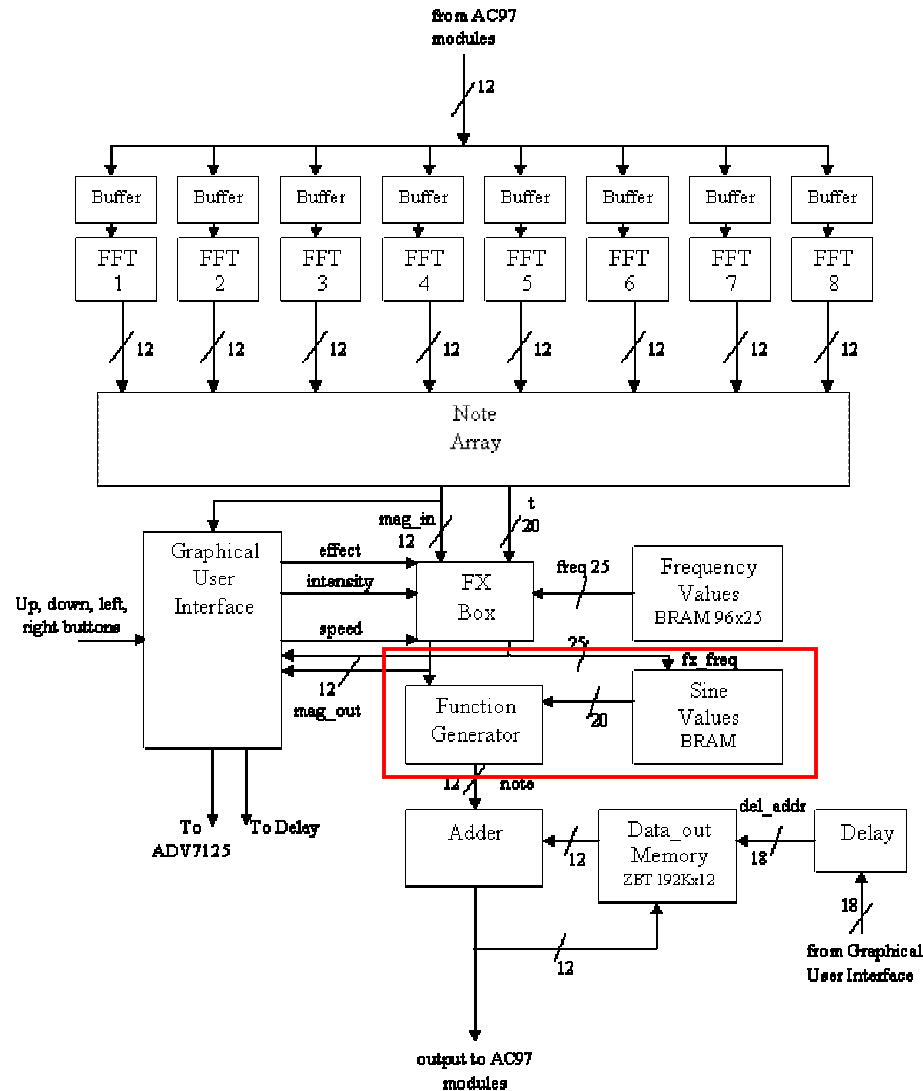
# FX

- Performs arithmetic on magnitude and frequency
- Outputs to Function Generator
- Exact frequency values for notes read from BRAM
- Controlled by user through GUI
  - effect
  - intensity
  - speed

# Effect Options

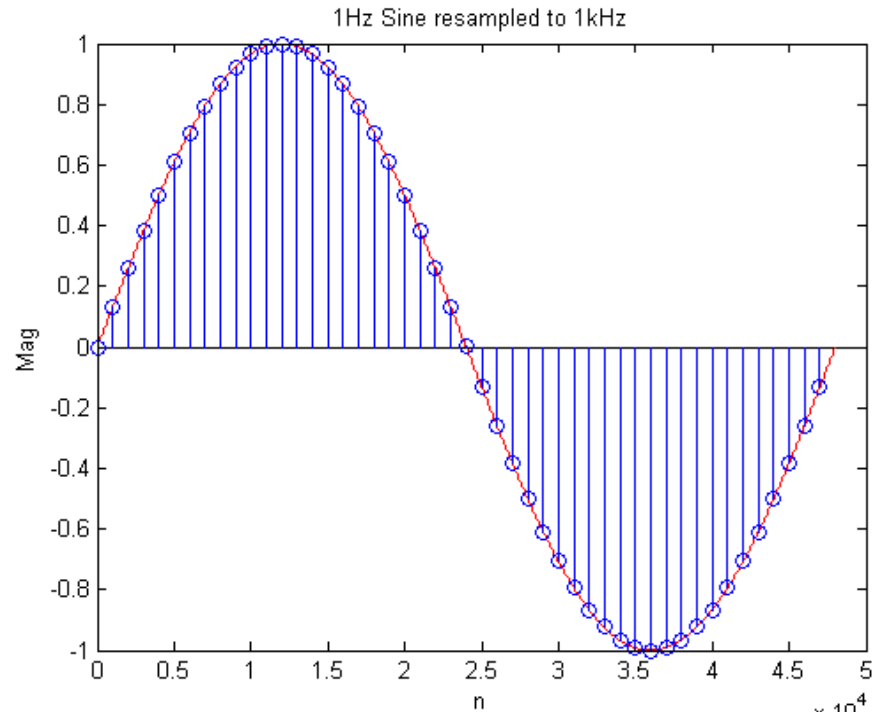
- Vibrato
- Pitch Bend
- Arpeggiator
- Harmonizer
- Delay

# Function Generator



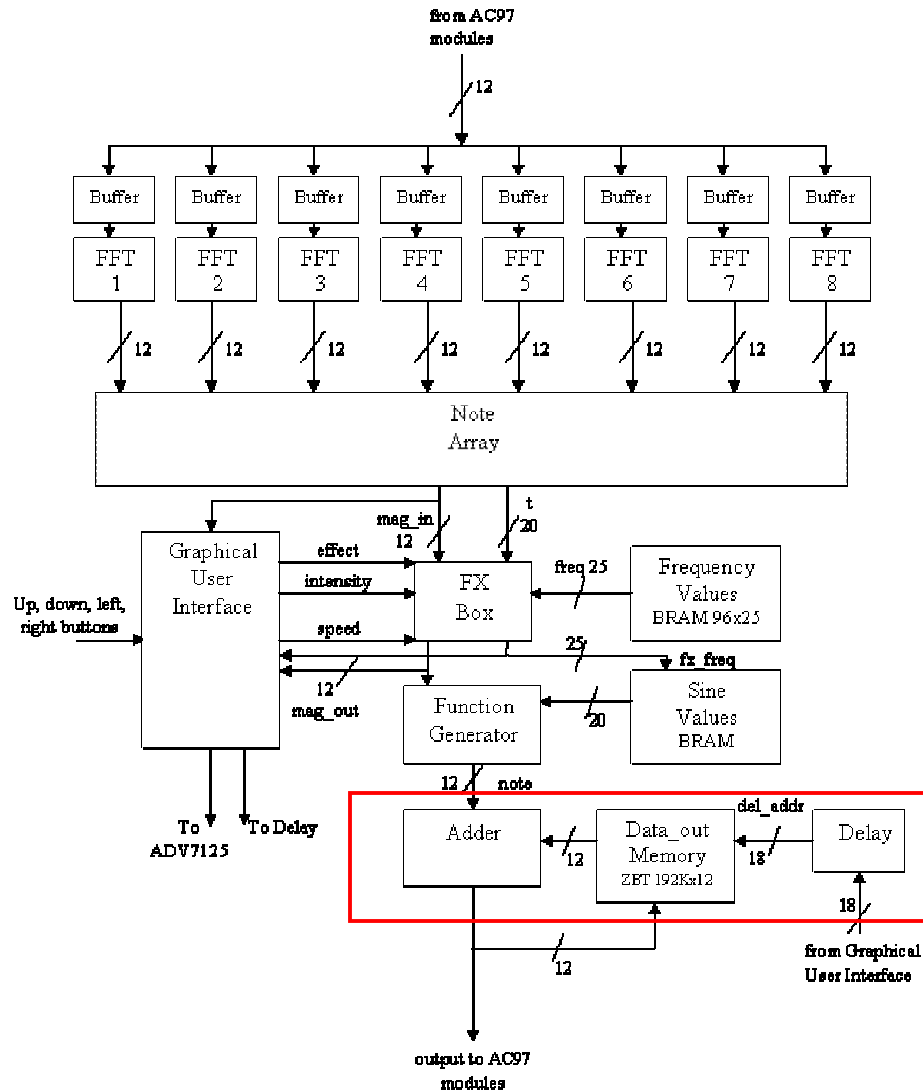
# Function Generator

- Calculates  $A\sin(\omega n)$ , where  $A$  is the magnitude received from the FX module
- Receives values for  $\sin(\omega n)$  from LUT



Output from function generator is sampled at 48kHz, so to create different frequencies, a  $48000/N$  Hz sine function is sampled at  $N/f$  points, where  $N$  is the number of samples and  $f$  is the desired frequency.

# Adder and Delay

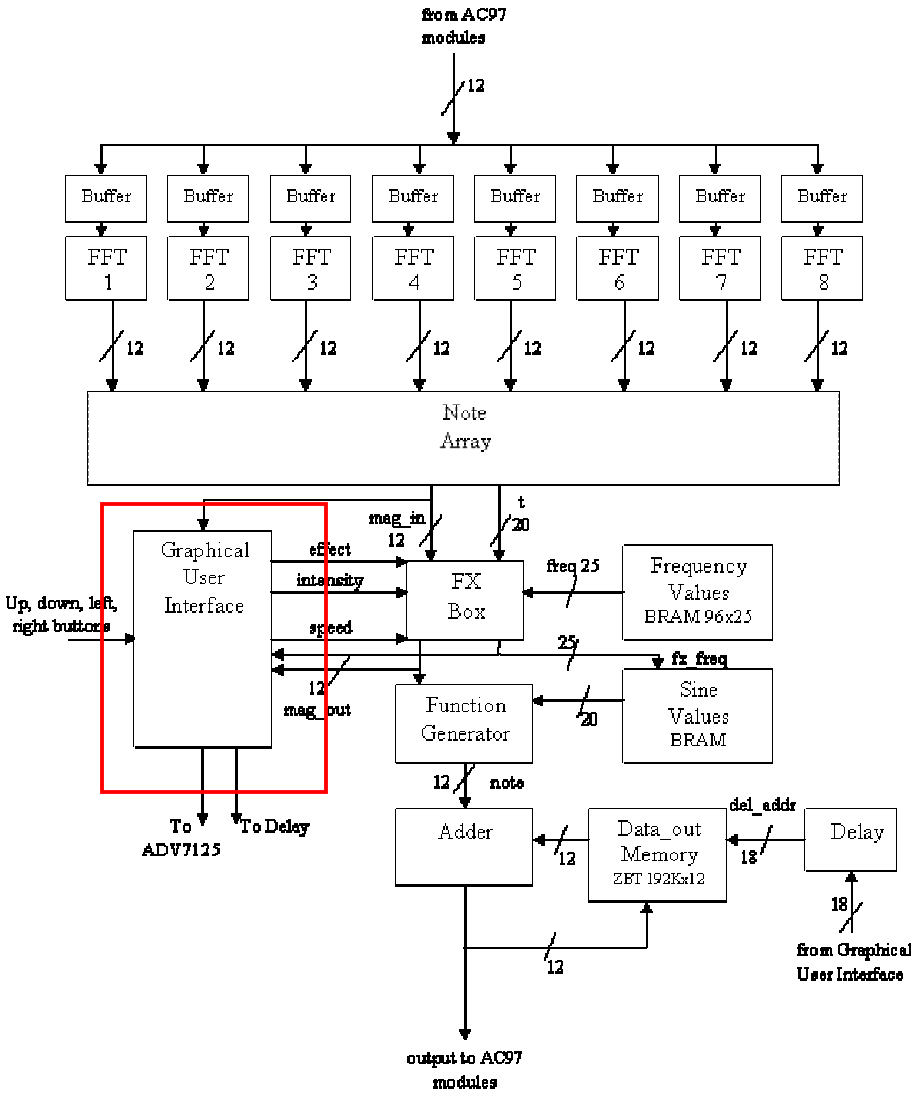




# Adder and Delay

- Sums together outputs from Function Generator and any delayed signals
- Delay length determined by user in GUI
- Maximum delay is 4 seconds
- Outputs to AC97 module @ 48 kHz

# GUI



# GUI

- Visualize effect options
- Input from labkit buttons
- Outputs parameters to FX module
- Displays wet and dry spectra

# Tying it all together

